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The Warp Sizing Study

THE Massachusetts Institute of Technology has been selected by U. S. Institute for Textile Research, Inc., to conduct its warp sizing research, and the following committee will represent U. S. Institute in the administration of the study: Mr. Wright Bolton, agent rayon division, Pacific Mills, Lawrence, Mass., chairman; Dr. J. B. Quig, Du Pont Rayon Co., New York, N. Y., and Dr. H. A. Neville, physical chemist, Lehigh University, Bethlehem, Pa.

These and other essentials of the organization of this first research co-operatively financed under the auspices of U. S. Institute, are the result of a meeting of the Board of Directors and the Research Council held in New York City Feb. 15. The study will be started just as soon as the director has been selected and the initial program of work is completed.

Confidential Progress Reports

WHILE final results of this two-year study of warp sizing will be published in *Textile Research* and made available to all members of U. S. Institute, only those who are Contributing members (dues $100 a year) will receive the confidential progress reports of results of the research. All who contribute to the co-operative financing of this study at $100 a year for two years receive Contributing memberships in U. S. Institute at no extra cost for dues. The directors of the Institute have, therefore, adopted a basic policy that all Contributing members shall hereafter qualify to receive confidential progress reports of all Institute researches. In the case of the warp sizing research this means that each Contributing member receives the confidential advance reports of a $10,000 study for a two-year membership, or $200, and similar reports of all other Institute researches conducted during the same period. It also means that they will have the benefit of valuable research results for from six months to a year before they are made public.

(*Continued on page 239*)

Diameter Ratio of Silk Filaments as Related to Two-Tone Dyeing

By FRED MENNERICH * and O. A. HOUGEN †

Abstract

One of the most insidious and troublesome causes of two-tone dyeing in silk fabric has been traced to a difference in the average diameter ratios of silk filaments in two adjoining sections of the same fabric. By diameter ratio is meant the ratio of the smallest to the largest diameter of a given cross-section. When this average difference exceeds .04, two-tone dyeing becomes noticeable and extreme when it exceeds 0.12. This difference in diameter ratio is not noticeable to the eye by microscopic examination of cross-sections except in rare instances, but it can be determined only by statistical measurements of 100 filaments for each yarn to attain a desired accuracy of 1% in the average value. The chief value of this discovery is to make obvious the futility of attempting to correct for this particular cause of two-tone by any chemical adjustments in soaking, boiling-off and dyeing. It also again emphasizes the danger of mixing lots of silk cocoons at the filatures. It is possible that an auxiliary method of grading raw silk can be developed on the basis of diameter ratio. Variations in the diameter ratios of different lots of Japanese cocoons from several districts are presented.

Introduction

IN the dyeing of woven or knitted silk fabrics the appearance of slight color differences in adjoining sections of the same fabric is of frequent occurrence and the cause of great financial loss in producing substandard merchandise. In woven fabric color differences appear usually as broad bands in the filling; in silk stockings the trouble is exhibited by a sharp demarcation between the leg and foot portions. During the year 1931 this trouble was particularly prevalent. This defect is referred to in the trade as "two-tone" dyeing and the term as commonly used includes any difference in value, chroma or hue, the three dimensions of color as defined by the Munsell system. Differences in value or chroma can usually be traced to differences in the mechanical construction of yarn or fabric in adjoining sections such as denierage, twist, courses per inch, ply, exfoliation and yarn diameter. The causes of differences in hue are much

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more puzzling and frequently impossible to analyze. It is commonly stated that differences in hue are due to chemical causes such as differences in soaking, age, storage, oxidation, bacterial action, tinting, natural color and nature. To obviate these causes the necessity of strict uniformity of lots and similarity of treatment has been repeatedly recommended and practised.

Previous Work

Much attention has been given to finding the causes and remedies of two-tone dyeing. Chamberlin * has listed 21 probable causes. On August 4, 1932, the Silk Committee of the National Association of Hosiery and Underwear Manufacturers listed six principal causes with recommended remedies. However, despite all precautions taken in uniform soaking, uniform tinting, uniformity in machine adjustments, uniformity in yarn and stitch formation, restriction of yarns to same lot and same conditions, still two-tone develops due to some characteristic of the raw silk itself and not to any variation in subsequent mechanical or chemical treatment. W. P. Seem has attributed this insidious cause of two-tone to the color and nature of raw silk and accordingly proceeds to classify silk into lots according to natural color and to differences in nature. Seem classifies silk according to nature by measuring the enclosed area of the stress-strain diagram when wet raw silk skeins of definite size are subjected to alternate flexing in the inclined plane serigraph.

This investigation deals solely with the most troublesome type of two-tone evidenced by a difference in hue. Much effort has been expended in attempting to correct for this trouble by chemical treatment in soaking, boiling-off or dyeing. Slight improvements have been effected in certain instances by the use of a mild oxidizing agent, such as sodium perborate, in the boil-off bath, and by use of pine oil, or Gardinol, as selective wetting agents, in the dye bath. These remedies have never been reliable. Classification of silk according to natural color and to nature has proved valuable. However even by this classification the authors have found two-tone dyeing within single skeins particularly of soft natured silk.

Since two-tone is a dyeing problem, it would be logical to expect that classification could be done upon raw silk skeins after tinting in the soaking bath. However, the unexpected situation is encountered that two-tone dyeing never shows in dyed or tinted skeins whether dyed or tinted in the gum or after boiling-off. Hence any attempt to classify raw silk skeins by differences in shade of tinting of raw silk skeins after soaking has proved futile. Furthermore no two-tone is manifest in dyed skeins of boiled-off silk, and yet a difference appears after the skein is fabricated.

Difference in Diameter Ratios of Filaments as a Cause of Two-Tone

The cross-section of the silk filament is roughly elliptical or obtusely triangular in shape with rounded corners. By carefully measuring the ratio of the smaller to the larger diameter or direction of each silk filament in cross-section, the first author found a marked difference in the average ratio among different lots of silk. Applying this same measurement to two silks which showed a sharp contrast in two-tone, which could not be ex-

* D. S. Chamberlin. *Mell. Tex. Mo.*, April, 1932.

plained on the basis of any known cause, it was found that a distinct difference in diameter ratio existed between the two silks and that this difference increased as the two-tone became greater. This variation in diameter ratio is not noticeable to the eye by microscopic examination, except in rare instances, but can be determined only by statistical measurements of hundreds of filaments.

Comparing Figs. 1 and 2 a very marked dissimilarity in shape and diameter ratio will be noted. This represents an extreme case where the difference in diameter ratio is 0.610 — .398 or 0.212. Ordinarily the unlike-

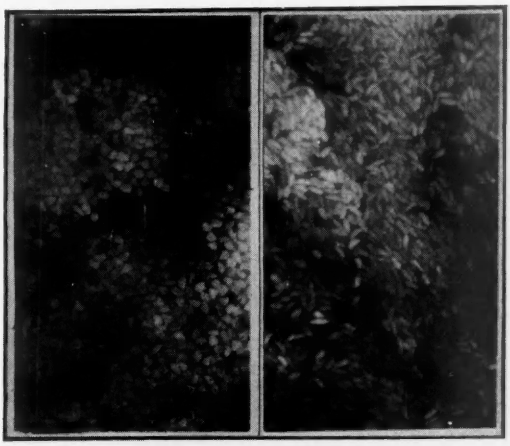


FIG. 1 × 165 Avg. dia. ratio, 0.610 FIG. 2 × 165 Avg. dia. ratio, 0.398

Extreme variation in diameter ratios of Japanese silk filaments.

ness is too slight to be noticed in cross-section except by statistical measurements, even though extremely visible as two-tone in fabric. A difference of .04 is sufficient to cause visible two-tone dyeing in fabrics.

The results in Table 1 were obtained from full-fashioned stockings which showed different degrees of two-tone at the demarcation between foot and leg portions.

An examination of the data in Table 1 shows that there exists a remarkable relation between the degree of two-tone and the difference in diameter ratios on the two sides of the foot splice. It will be seen that the contrast in shade increases progressively with increase in the difference between diameter ratios, and that the darker hue corresponds in each case to the smaller ratio. It is remarkable that this difference in two-tone is not noticeable when the two silks are in skein form, whether in the raw skeins, after tinting, or even after boiling-off and final dyeing. Possibly in throwing, the individual filaments are partly oriented so as to align the larger diameters more nearly in the same direction. This orientation of

TABLE 1

Relation of Two-Tone Dyeing to Difference in Diameter Ratio

Degrees of Two-tone	Diameter Ratio		Difference in Diameter Ratio	
	Darker Shade	Lighter Shade		
Extreme	.567	.682	.115	average .122
Extreme	.577	.710	.133	
Extreme	.582	.702	.120	
Marked	.644	.715	.071	
Slight	.648	.688	.040	
None	.705	.707	.002	

filaments is clearly shown in Fig. 2. Even assuming random orientation, the relative surface exposure of the wider dimensions will be greater as the diameter ratio decreases.

Diameter Ratios of Silk Filaments in Different Lots of Cocoons

It now became desirable to see if differences in diameter ratios could be detected among different lots of cocoons. Through the courtesy of Mr. C. Walter Seidel, certified cocoons were obtained from Mr. Sangyo Shikenjo of the Sericultural Institute of Nakano, near Tokyo, Japan. Three different breeds of cocoons were obtained, representing spring white, autumn white and spring yellow silks. Cocoons from each breed were collected from each of six different districts of Japan, representing northern, central and southern latitudes. These six districts produce 79% of the silk production of Japan.

Experimental Procedure

To assure no possibility of prejudice in measurements all examinations were made upon cocoons designated by code numbers which were not revealed until the examination was completed. A sample cocoon was cut in half longitudinally. A thin shell of silk was removed from the outside of the cocoon and also from the inside. These parts (about 10% of the silk) were discarded, since they are not used in hosiery yarns. The half cocoon was soaked for five minutes in boiling water to soften the sericin and loosen the filaments. The softened cocoon was pulled apart and stretched into a long ribbon. This was doubled into a bundle five inches in length. One end of the bundle was knotted and the remainder combed until untangled. The sericin was removed by boiling for one hour in a solution of 1% soap plus 0.1% sodium carbonate. A small bundle of filaments was selected, twisted and adjusted to size by a special thread sizer. In cross-sectioning the bundle was drawn through a tiny hole in a thin metal plate by means of a fine wire loop. The projecting ends of silk were cut off with a sharp razor blade flush with the two smooth faces of the metal plate. The metal plate was mounted upon the stage of a compound microscope strongly il-

luminated by the substage mirror with transmitted light from a bright carbon arc lamp. The image of the cross-section was projected upon a ground glass screen ruled co-ordinately. A magnification of 500 diameters was obtained. Measurements of the two diameters of various filaments were made on the ground glass by means of a small celluloid scale with special graduations reading directly in microns.

Measurements were made at regular intervals over the entire projected area, measuring 200 filaments in each cross-section. The average value of 200 measurements was recorded as representative of one cocoon. Three cocoons were selected to represent each lot. The average diameter ratio of each lot thus involved 1200 measurements of diameter.

Precision of Measurements

The average deviation of one observation of diameter ratio, from the average value of 0.637, was 0.111, or 17%. The corresponding deviation of 200 measurements was 1.2%. The probable error of the average of 200 measurements was 1%. For an accuracy of 2%, measurement of 75 diameter ratios is sufficient.

Average Diameter Ratio for Each Lot

To determine the probable variation of average diameter ratios for different cocoons of a single lot, similar measurements were repeated on three cocoons from each lot, and again for 18 different lots. The average deviation of average diameter ratios of single cocoons within each lot was 0.017 or 2.6%. The average deviation of single cocoons among all lots was 0.042 or 6.5%. These observations indicate that variations in diameter ratios cannot be fully accounted for either by variation within a single cocoon or within a single lot, but must be due chiefly to some intrinsic differences among different lots. The variation in diameter ratios among different lots of cocoons was 2.5 times greater than variation within a single lot of cocoons. The extreme range of average yarn diameter ratios among different lots was 0.17% or 27%, whereas the average deviation within each lot was only .017, or 2.7%. The extreme range is ten times the variation within one lot.

Results on Cocoons

It was suspected that variations in diameter ratios among different lots of cocoons could be accounted for by breed of cocoon or climatic conditions. Not knowing the exact climatic conditions involved in the culture of these cocoons, correlation was made against geographical latitude instead.

The summarized results of all 18 lots representing over 20,000 measurements are given in Table 2 arranged according to district, breed and season.

These data show that for the particular cocoons tested the diameter ratio within the same breed of cocoons varied with the latitude; the spring cocoons, both white and yellow, show an increasing diameter ratio as sericulture proceeds from the southern to the northern districts of Japan; the reverse is found in the autumn breed. Also it is apparent that the spring yellow silk is flatter than the spring white. No general conclusions are implied by these remarks.

TABLE 2

Average Diameter Ratio of Cocoon Filaments for Different Districts, Seasons and Breeds

No.	Districts	Latitude	White				Yellow Spring	
			Spring		Autumn			
			E18 × C106		J110 × C105		E16 × C14	
1	Oshu	North	.713	.713	.607	.607	.617	.617
2	Kwanto	Central	.693		.640		.551	
3	Shinshu	Central	.686	.684	.614	.646	.631	.590
4	Tokaido	Central	.674		.684		.588	
5	Shikoku	South	.640		.710		.538	
6	Kyushu	South	.647	.643	.687	.699	.597	.567
	Average		.675		.657		.587	
	Average for all cocoons .666							

Average Diameter Ratios Among Different Bales

It next became desirable to determine what variation might be found in diameter ratio among different books within a bale of raw silk, and also among different bales, in order to determine whether or not such measurements could be used as a basis of silk classification for the purpose of reducing two-tone dyeing. Because of the indiscriminate mixing of cocoons at the filature, it was thought that possibly average filament diameter ratios for a given bale would always be the same so that classification of silk by yarn diameter would not be possible. That this is not true is revealed by the fact that wide variations were found in average yarn diameters from bale to bale and that these variations were reflected in extreme two-tone dyeing when silks from two such different bales were used in adjoining yarns of silk stockings.

Eighty books of raw silk were selected by the Phoenix Hosiery Company from 20 bales of silk, representing two 10-bale lots, taking four books from each bale. A sample of silk was stripped from one skein in each selected book and measured for diameter ratio. The following results were obtained: Average diameter ratio of 20 bales, 0.63. Average deviation among books in a single bale, 0.018. Average deviation among different bales, 0.023. The summarized results are given in Table 3.

The average deviation within a single bale, .018, is almost identical with the deviation within a single lot of cocoons, .017. Diameter ratios in different skeins varied from 0.55 to 0.69 which is a greater variation than found among the different lots of cocoons which varied from 0.61 to 0.71. The variations among the averages of different bales ranged from 0.61 to 0.66 which is one-half the variation found among different lots of cocoons.

The first thing to be noted is that the average deviation with a single bale is the same as the average deviation with a single lot of cocoons. This indicates that the raw silk was made up of a uniform quality of cocoons and was not mixed from different districts or seasons. The average deviation of diameter ratio among different bale lots was .023. The probability

TABLE 3

Diameter Ratios

Bale No.	Book 1	Book 2	Book 3	Book 4	Average per Bale	Remarks
70250	.65	.68	.63	.63	.65	Spotted
70251	.63	.62	.62	.59	.615	O.K.
70252	.65	.62	.61	.62	.625	O.K.
70253	.63	.59	.58	.64	.61	Mixed
70254	.61	.64	.64	.67	.64	Spotted
70255	.58	.60	.63	.59	.60	Mixed
70256	.64	.65	.62	.66	.64	O.K.
70257	.69	.68	.67	.55	.65	Bad Spot
70258	.56	.64	.64	.65	.62	Bad Spot
70259	.67	.65	.65	.67	.66	O.K.
70310	.67	.64	.62	.62	.64	Spotted
70311	.61	.62	.62	.65	.625	O.K.
70312	.63	.60	.63	.60	.615	O.K.
70313	.66	.60	.66	.62	.635	Mixed
70314	.65	.62	.61	.67	.64	Mixed
70315	.66	.61	.58	.61	.615	Spotted
70316	.62	.62	.64	.63	.63	O.K.
70317	.62	.62	.60	.63	.62	O.K.
70318	.67	.62	.61	.58	.62	Spotted
70319	.64	.64	.67	.62	.64	Spotted
Average of 80 books					.63	

of finding this variation among different bales was 2.2 times as great as finding it within a single bale. The average deviation among different bales was 1.3 times as great as within a single bale.

Grading Raw Silk by Diameter Ratio

The different books of silk tested were grouped on the basis of diameter ratios. Yarns were thrown from four books showing different diameter ratios and then knit into tubing with alternate bands of different silks designed to show contrasting yarns. The results were as follows:

Diameter Ratio Difference	Number of Comparisons	% Two-tone
.01	99	12%
.04	92	4%
.09	106	10%
.10	116	13%
.13	142	9%
.14	113	13.3%

The above column of differences in diameter ratios refers to skeins tested and not to the tubing bands examined. The skeins tested might not have been representative of the books as thrown, hence full agreement could not be expected. Furthermore the actual cause of two-tone in the tubing was not verified as due to diameter ratio difference.

The first and fourth lots are out of line. Unfortunately the 20 bale lot of silk as a whole showed remarkable uniformity of diameter ratio and little two-tone in actual knitting.

Whether or not this method can be used as a basis of grading silk as to two-tone is problematical.

General Conclusions

The chief value of this study is to show that a very insidious cause of two-tone dyeing is due to differences in diameter ratios between silks in adjoining sections of fabric. It also indicates the futility of attempting to correct for this type of two-tone by chemical treatment in soaking, boiling-off or dyeing.

These results are of particular value in again showing the necessity of not mixing lots of cocoons in the filatures or not mixing skeins or books in the inspection departments and exporters' warehouses before exportation from Japan.

It would be interesting to determine if there is any relation between diameter ratio and the classification of silk according to nature by the inclined plane serigraph. A few restricted tests failed to show any relation.

Whether or not the two tone nature of silk can be graded on the basis of diameter ratio is uncertain. Even though possible, the required additional cost of two cents per pound is perhaps prohibitive at the present low value of silk.

Acknowledgments

The authors gratefully acknowledge the aid of the Holeproof Hosiery Company and Phoenix Hosiery Company of Milwaukee in subsidizing this investigation and for so generously releasing the information for publication; of C. Walter Seidel for supplying the selected cocoons from the Sericultural Institute of Nakano; of W. P. Seem for supplying and classifying the nature of several skeins of silk; and of Harold Schee for conducting plant tests on grading.

Correction

On p. 207 of the February number of TEXTILE RESEARCH the description of the upper and lower abscissae of Fig. 5 should read as follows: Upper—Lbs. of Na_2CO_3 per 100 lbs. of Thrown Silk. Lower—Lbs. of Soap per 100 lbs. of Thrown Silk.

The Deterioration of Silks by Light of Different Wave-Lengths

By ESTHER BRUNER and MINA GOEHRING *

Abstract

The effect of light rays of different wave lengths upon certain unweighted and weighted silk fabrics is discussed. Specimens of each silk were exposed to the entire spectrum given by an S–1 Sun Lamp and to limited regions of the spectrum. Glass filters were used to filter out the undesired rays. Tensile strengths of specimens after exposure to light rays were compared with those before exposure in order to determine the deterioration taking place.

X-ray diffraction patterns of the silks were made. Lead-weighted silk gave a typical powder pattern; 50% tin-weighted silk gave slight evidence of fibreing; 43% tin-weighted gave a much stronger fibre pattern. Diagrams of the unweighted silk before exposure to the light source and after exposure to the entire spectrum appeared similar, but photometric analysis indicated that exposure of silk to light results in a decrease in fibre orientation causing the long fibre arc to expand toward the character of a powder pattern.

Summary

Results obtained seem to indicate the following facts:

1. Lead-weighted silk shows greater deterioration upon exposure to regions of the spectrum studied than pure-dye or tin-weighted silks.

2. The greatest deterioration in all of the silks under observation occurred during exposure to the entire region of the spectrum. Since the filter transmitting rays between 2600 and 4050 Å caused much greater decrease in tensile strength than that which transmitted rays between 3490 and 4050 Å, it appears that the decrease in tensile strength under exposure to the unfiltered light source is due primarily to those rays below 3490 Å.

* Contribution No. 40, Department of Home Economics, Kansas Agricultural Experiment Station, Manhattan, Kansas.

3. Deterioration appears to become more rapid as the time of exposure is increased beyond 72 hours. This is particularly true in the case of the lead-weighted samples.

Introduction

One of the problems confronting the research worker in the field of textiles today is the action of light on textile fibres. It is known that long or frequent exposure to sunlight results in weakening of all textile fibres, but factors concerned with deterioration have not been studied until recent years.

Although silk is one of the strongest fibres in many respects, it is more sensitive to light than most other fibres. This increased sensitivity to light may be due, according to Heermann and Somner,[1] to fineness of the filaments which favors a higher absorption of light by yarn or fabric.

There has been some disagreement among investigators as to what properties of light are responsible for its deteriorating effect. Doree and Dyer [2] attribute its destructive action to the ultra-violet rays, either acting directly on the fabric, or forming ozone which then attacks the fabric. Other authorities believe that the ozone which develops acts strongly upon silk in the presence of moisture. According to Johnson,[3] Heermann concludes that it is the ultra-violet rays rather than the ozone which cause the deteriorating effect. Stockhausen,[4] as well as Heermann, found that the kind and amount of weighting influences the durability of the silk fibres.

The study here presented was carried out with a view to obtaining more information as to the region of the spectrum which causes the greatest deterioration of pure-dye silk and certain weighted silks. Decrease in tensile strength of the silk was taken as a measure of its deterioration. X-ray pictures were taken in an attempt to discover the structural differences between unweighted and weighted silks and, if possible, changes within pure-dye silk that had been brought about by exposure to light.

Apparatus

A mercury arc lamp has been used as the light source in many studies relative to the effect of light on silk. Because the odor of ozone was so pronounced, and the presence of considerable quantity of the gas was definitely proven by the failure of uranyl sulfate to show any decomposition under this light source,[3] the mercury arc lamp was discarded in favor of a light source which did not cause the formation of considerable quantities of ozone. In this way any changes which the silk fabrics might undergo could be more definitely attributed to the effect of the light rays rather than to the presence of a considerable amount of ozone. A General Electric S–1 Sun lamp was chosen as best suited to this need. A watt-hour-meter and recording ammeter were attached in order to keep a record of the energy entering the lamp during each experiment and of the actual time of exposure of the samples.

Corning-glass filters supplemented by filters from the Cambridge Botanical Supply Company were used for confining the radiation to definite regions of the spectrum. Spectrograms of the filters and of the light source were made with a Bausch and Lomb Quartz Spectrograph, using for the light source a Silver-tip carbon arc obtained from the National Carbon Company.

The experimental room was equipped with a Carrier Unit Air Conditioner and a Friez hydrothermograph, which enabled an accurate check to be kept of the temperature and humidity throughout each experiment.

All breaking strength determinations were made with a Combination Scott Tester. A Lowinson's micrometer was used for counting threads. Thickness of the fabric was measured with a Stickney gauge.

In the X-ray work a gas tube of Siegbahn type with a water cooled copper target ($K_a = 1.54$ A.U.) was used as the source of radiation. Since the long fibre dimension is easily distinguished with reference to the *A* and *B* lines, filtering to obtain a monochromatic beam was deemed unnecessary, and would have greatly increased the time required for exposures. The tube was run at 35 K.V. and 10 milliamperes, which required an exposure of 6–8 hours with the samples held 2.5 cm. from the film. When it was found necessary to run the tube at a lower voltage or with less current the calculated increase in the time required for a run was made.

The cassettes or film holders were of the flat type and were placed perpendicular to the X-ray beam. Pin holes 3.25 ins. long and .025 in. in diameter were used. The silk to be tested was prepared by raveling threads from the specimens and removing the twist as much as possible A bundle of parallel fibres consisting of 40 of these threads was wound with a single thread of the sample and was then mounted over the outer pin hole with the fibre axis perpendicular to the X-ray beam. The number of windows in the tube enabled three pictures to be taken in each run.

Intensity measurements of the X-ray patterns were made in an effort to discover differences that might exist in samples exposed to the sun lamp and those which had not been exposed. The photometer used in making these measurements consisted of a Weston photoelectric cell, a six-volt automobile headlight drawing a constant controlled amperage, and a prism and lens condensing system for focusing the image of the filament on the film. The film was mounted on the micrometer carriage of a traveling microscope and was moved horizontally across the light beam. The cell was connected directly to a Leeds and Northrup high sensitivity galvanometer No. 7552, having a sensitivity of 2.5 mm. per microvolt.

Experimental Procedure

A plain-woven, undyed, raw silk fabric was obtained from Belding-Heminway Company. It was sent to the United Piece Dye Company for removal of sericin and for weighting. One portion of the degummed silk was left unweighted; other portions were weighted with approximately 50% lead, 50% tin, and 40% tin. Analyses of these silks for the percentage weighting were made according to the method recommended by the Bureau of Standards.[9] The per cent of weighting was also checked by determining the ash weight of pure dye or unweighted silk and of weighted silks. Results of these analyses (the average of duplicate determinations) are given in Table 1.

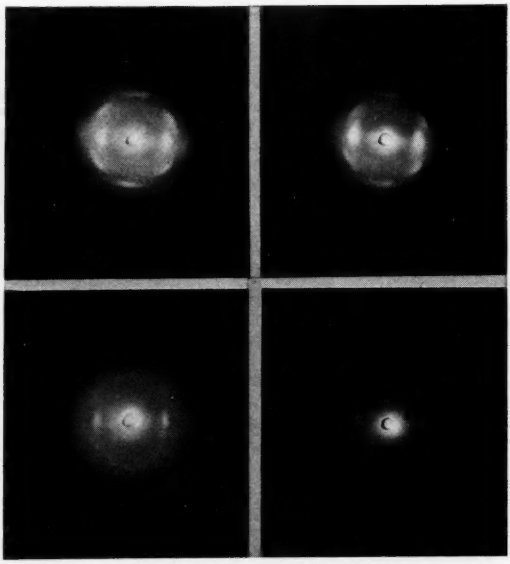
Duplicate checks on lead-weighted samples were more difficult to obtain than on others. Analysis by the Bureau of Standards' method gave somewhat higher results than by the ash weight method. However, variation in percentage weight between any two determinations never exceeded 1.4.

Physical analyses of fabrics were made according to specifications recommended by the American Society for Testing Materials.[10] Weight per

TABLE 1

Percentage Weighting

Kind of Silk	Ash Method Weighting %	Bureau of Standards Method Soluble Finish %	Bureau of Standards Method Weighting %
Lead Weighted	52.86	3.64	53.49
Tin Weighted (Approx. 50%)	49.65	6.61	50.02
Tin Weighted (Approx. 40%)	42.94	5.89	43.02
Unweighted	0.414		



X-RAY DIAGRAMS OF SILKS *

Upper left, pure-dye silk unexposed to light source; upper right, pure-dye silk exposed to light source; lower left, 43% tin-weighted silk; lower right, 50% tin-weighted silk.

square yard was determined on dry samples. Specimens used to determine breaking strength of both warp and filling yarns were prepared by the strip method. Determinations were made after samples had remained for six hours in the experimental room kept at a relative humidity of 63–67% and

* Diagrams from which photometric measurements were made were destroyed by fire. These diagrams, made from the same fabric specimens, were obtained through the courtesy of the Chemistry Department, University of Illinois, where we were permitted to use a Mueller X-ray tube.

a temperature of 69°–72° F. Table 2 gives the results of these physical tests.

TABLE 2

Physical Analyses of Silk Fabrics

Silk Tested	Weight per sq. yd. in oz.	Thickness in ins.	Thread Count		Breaking Strength in lbs.	
			Warp	Filling	Warp	Filling
Unweighted.....	1.13 1.17	0.0057	176	75	43.0	20.0
Lead Weighted.....	2.76 2.69	0.0069	180	77	52.3	19.8
50% Tin Weighted..	2.57 2.57	0.0077	181	80	52.0	20.2
43% Tin Weighted..	2.49 2.49	0.0073	181	78	52.0	18.9

Greater variation in the weight per square yard of lead-weighted silk may be due to the fact that weighting may be less uniformly distributed than in tin-weighted samples.

Before exposing silk specimens to radiation from the sun lamp, spectrograms of various filters and solutions were carefully considered in order to choose filters which would transmit rays within a definite and somewhat limited region of the spectrum. Intensity measurements of filters chosen were made by the uranyl sulfate method in order to determine the per cent of light transmitted. Table 3 gives a list of the filters or combination of filters chosen with their thickness, wave length of light passing through, and the per cent of light transmitted as measured by the uranyl sulfate decomposition when two kilowatt hours of energy entered the lamp.

Silk samples prepared as specified were kept in the experimental room in trays protected from light for at least six hours before exposure to filtered or unfiltered rays of the sun lamp. After exposure they were again returned to the trays for six hours before breaking strength determinations were made. The experimental room was kept as uniformly as possible at a relative humidity of 64–66% and a temperature of 69°–73° F. When any considerable variation from these conditions occurred or continued for any length of time the results of that experiment were discarded. Results were taken in a few cases when very high outdoor temperatures made it impossible to keep the experimental room much below 80° F. In these cases the relative humidity was kept at 67–68% and the temperature 78°–83° F. The majority of tests were run for a period of 72 hours, and the energy entering the lamp was approximately 34.0 kilowatt-hours. In the 5-day or 120-hour exposures 57.1 kilowatt hours of energy were used.

TABLE 3

Wave Length Transmission and Light Transmission of Filters

Filters Chosen and Thickness	Wave Lengths Transmitted in A. U.	Per cent Transmission
Corning Glass		
No. 986 (4.96 mm.)	2600–4050	70.13
No. 986 (4.96 mm.) + No. 534 (2.15 mm.)	3490–4050	25.57
No. 584 (7.96 mm.) + No. 428 (4.28 mm.)	3400–3850	13.35
Cambridge Botanical		
No. 6 (5.31 mm.) + No. 11 (4.97 mm.)	3900–4600	17.01
No. 7 (4.80 mm.)	4800–5900	11.50

Control samples, prepared according to specifications used for test samples, were not exposed to the light at any time, but were kept on trays in the experimental room for six hours before breaking strength determinations were made. Breaking strengths of unexposed specimens and those exposed to different light rays are recorded in Table 4.

Breaking strength determinations were also made upon specimens which had been exposed for varying periods of time to unfiltered rays from the light source. These results are presented in Table 5.

X-ray patterns of unweighted and weighted silks were obtained before exposure to light rays, and of unweighted and lead-weighted fabric after five days exposure under the sun lamp. In both cases the pure-dye diagrams were typical fibre patterns. In order to determine whether the patterns of unexposed and exposed silks were identical, measurements of the intensity of the fibre patterns were made with a photometer. Before taking these measurements an axis was established as nearly as possible through the center of the diagram parallel to the fibre axis, and 30° angles were laid off on each side of this line at the center. Intensity measurements of the two outer fabric arcs were then made through the axis and through the 30° angle in each quadrant, and the ratio of the maximum intensity at the angle to the maximum intensity at the axis was calculated. In order to compensate for any error due to centering of the diagram the average of these four ratios was taken for each diagram. Duplicate patterns of exposed and unexposed silk taken on different cassettes were analyzed in this manner. Results of these measurements are given in Table 6.

Discussion of Results

From results shown in Table 4 it will be seen that the pure-dye and two tin-weighted fabrics, when exposed to rays of the spectrum above 3400 Å, *i.e.*, under all filters except No. 986, showed equal or slightly greater breaking strength than that of the control sample. The lead-weighted fabric showed a decrease in every case, with the exception of rays transmitted by filter No. 7, which were those of longer wave-length. These facts

TABLE 4

Breaking Strength (in pounds) of Silks Exposed to Filtered Light Rays of S-1 Sun Lamp

Kind of Silk	Filter Used	Hours of Exposure	No. of Detm.	Av. Breaking Strength in lbs.	Mean Deviation
Pure Dye	6 + 11	72	12	42.9	0.96
	584 + 428	72	21	44.0	1.75
	986 + 534	72	12	44.5	1.27
	986	72	18	41.5	1.73
	7	72	15	43.3	1.17
	none	72	31	39.6	1.62
	986	120	12	37.4	2.62
	none	120	10	33.1	1.74
	control	none	7	42.6	1.14
Lead Weighted	6 + 11	72	27	51.0	2.03
	584 + 428	72	21	50.8	2.06
	986 + 534	72	24	50.4	1.83
	986	72	25	38.5	4.87
	7	72	33	52.7	1.88
	none	72	38	35.0	4.38
	986	120	9	33.8	1.98
	none	120	14	24.0	3.61
	control	none	5	52.3	0.70
Tin Weighted 50%	6 + 11	72	15	52.2	1.26
	584 + 428	72	12	51.4	1.36
	986 + 534	72	12	52.2	1.18
	986	72	15	48.1	1.70
	7	72	15	52.1	1.05
	none	72	33	45.3	2.54
	none	120	6	38.6	2.43
	control	none	6	51.9	0.65
Tin Weighted 43%	6 + 11	72	12	54.6	1.90
	584 + 428	72	15	52.7	3.35
	986 + 534	72	21	54.0	1.30
	986	72	12	49.7	1.33
	7	72	15	54.3	1.78
	none	72	23	46.6	1.89
	none	120	6	45.1	0.27
	control	none	5	52.0	1.60

seem to indicate quite definitely that the lower region of the ultra-violet spectrum, between 2600 and 3490 Å, *i.e.*, the difference in the rays transmitted by filters No. 986 + 534 and filter No. 986, cause greatest deterioration of both weighted and unweighted silks. The breaking strength of both

TABLE 5

Breaking Strength (in pounds) of Silks Exposed to Unfiltered Light Rays of S-1 Sun Lamp

Hours Exposed	0	6	8	12	14	15	18	20	24	47	93
Kind of Silk											
Lead-Weighted	52.3		48	46.8	48	47	49.1		45	41.3	
43% Tin.....	52.0					53.5	51.5	52	51.6	46.3	
50% Tin.....	51.9	51.3				51.3	51.0			47.8	42.8
Unweighted...	42.6						43.2				

TABLE 6

Spread of Intensity of the Long Fibre Arc in the X-ray Diagrams. Ratios of 30 Degree Intensity to Axial Intensity

	Cassette No. 1	Cassette No. 2
Exposed.....	0.715	0.642
Unexposed.....	0.651	0.576
$\frac{\text{Unexposed}}{\text{Exposed}}$	0.911	0.898

weighted and unweighted fabrics showed greatest deterioration when exposed to the entire region of the spectrum. In some cases this difference varied from the breaking strength of those exposed to filter No. 986 little more than the average deviation among samples within the individual test. Increase in breaking strength over that of the control, evident in many of these tests (6 and 7), indicates that exposure to light of pure-dye and tin-weighted samples results in a strengthening of the silk fibres followed by later deterioration. No evidence of this was observed in lead-weighted samples, which appeared to undergo steady and more rapid deterioration than other silks. The few tests which were run for shorter periods of time give evidence that lead-weighted fibres undergo alternate increase and decrease in strength up to a certain point, after which there appears to be a continual and rapid decrease in strength.

Elod, Pieper and Silva [11] state that in X-ray patterns 30% or more of tin compound completely masks the silk. X-ray diagrams of silk weighted to 50% gave chiefly a powder-type pattern of the tin compound with only slight evidence of a fibre pattern. The diagram of fabric weighted to 43% showed evidence of fibreing. Lead weighting gave a typical powder pattern, thus completely masked the fibre pattern. Typical fibre diagrams were obtained with unweighted silk.

X-ray patterns of lead-weighted silk that had been exposed to rays of the sun lamp for a period of five days again showed only the typical powder pattern, so it was impossible to determine from the diagram what change the fibre may have undergone upon exposure to light. The pure-dye diagram was a typical fibre pattern, apparently identical with that of the unexposed silk. Photometric measurements of the intensity of fibre patterns (Table 6) indicate that patterns of silk before and after exposure to

light rays are not identical. Exposure to light results in a decrease in fibre orientation. This tends to cause the long fibre arc to expand toward the character of a powder pattern.

Acknowledgment

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The Disposal and Recovery of Textile Waste Liquors

Chemical Precipitation of the Color-Shop Wastes

By MAXWELTON S. CAMPBELL *

Summary

The effect of coagulants on the waste liquors from the process of printing cotton goods is investigated. Treatment by coagulation with 4.5 pounds of lime per thousand gallons, using recirculated sludge as an aid to coagulation, followed by rapid sand filtration produces a clear and sparkling effluent suitable for discharge into streams containing fish and plant life, or for discharge into sewage treatment plants.

Chemical Precipitation of Color-Shop Wastes

THE Textile Foundation experimental plant, for studying methods of treatment of textile waste liquors in relation to stream pollution and discharge into domestic sewage disposal plants, was placed in operation on Jan. 16, 1934, at the Proximity Print Works, Greensboro, N. C., following a rather thorough series of preliminary tests. The plant was operated continuously in the period between Jan. 16th and May 3d on the treatment of waste dye liquors resulting from the printing of cotton goods.

The purpose of the studies on the treatment of color-shop wastes by chemical precipitation was to determine: (1) The chemical which would produce an effluent suitable for discharge into streams or sewage treatment plants at the least cost; (2) what final treatment, if any, is required; and (3), if the sludge produced incident to the treatment process is such that its disposal does not create a problem.

Although the performance of the plant during the period in which it has been in operation has shown that the action of the mixing tank leaves a great deal to be desired for perfect mixing, the following facts have been definitely established: That lime at a dose of 5.9 lbs. per thousand gallons is the best and most economical coagulant for the treatment of the color-shop wastes; that the dose can be further reduced to 4.44 lbs. of lime per thousand gallons by the use of recirculation of sludge as an aid to coagulation; that in cases where color reduction takes precedence over the pH, or biochemical oxygen demand, of the treatment plant effluent, some degree of filtration is necessary; and that the sludge produced is readily disposed of on sand drying beds.

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The waste liquor, treatment of which is discussed in this report, results from the process of printing dyes on cotton goods, and contains a heterogeneous mixture of dyes, and a considerable quantity of starch which is used in preparing the dye pastes. Most of the dye and starch reaches the waste channel as washings from the dye rolls and troughs, as they are removed from the printing machines after a pattern has been completed. The spillings, and tub and floor washings also contribute a part of the waste channel flow. These waste liquors are known as "color-shop wastes."

The color-shop wastes vary greatly in color and intensity during the day and are never the same color for more than a few minutes. The predominant colors include black, red, blue, brown, and green, of various intensities from deep to light, and with intermediate combinations. The waste is at all times highly turbid. Color-shop waste is one of the very few acid wastes discharged from plants dyeing cotton goods, large amounts of acetic acid being used in the process.

Procedure

The procedure for studying the method of chemical precipitation of the color-shop wastes involved the collection of representative samples for treatment; the proper control of the treatment plant; collection of samples for chemical analysis; and chemical analysis of the raw liquor and treatment plant effluents.

Collection of Waste Liquor

The two storage tanks were filled on alternate days by pumping from the color-shop discharge channel. That each tank should be charged with a composite sample of a total day's color-shop run was imperative. In order to ascertain the method to be followed in pumping, studies on the quantity and characteristics of the flow during the working day were made. The daily flow from the color shop was measured by placing a weir in the channel. The strength of the wastes was determined by taking biochemical oxygen demand samples every half hour during the day at intervals of thirty minutes. From the results of the flow studies it was found that the average daily discharge was 151,000 gallons for a working day of eight hours in which 100,000 yards of goods was printed. Of the daily flow 95.7% was discharged between 7:00 A.M. and 3:00 P.M., and 4.3% between 3:00 P.M. and 4:30 P.M. From 7:00 A.M. to 3:00 P.M. the strength of the wastes as measured by the biochemical oxygen demand varied only slightly, but from 3:00 P.M. to 4:30 P.M., after the printing machines had stopped and the dye rolls were being washed, the strength of the wastes was three times that discharged during operation before 3:00 P.M. A composite sample, then, was obtained by pumping 95.7% of the capacity of the storage tank before 3:00 P.M., the pump being operated for equal periods at intervals of one hour during operation of the printing machines. The remaining 4.3% was pumped during the " wash-down " period from 3:00 P.M. to 4:30 P.M.

Plant Control

As a preliminary step to operation of the plant the pH and acidity of the contents of the storage tank were determined, and jar tests made, to find approximately the correct chemical dose to be used in that day's opera-

tions. All chemicals, with the exception of lime, were applied in solution with a constant-head-orifice feed device. Lime was applied in the form of milk-of-lime with a floating siphon, and an electrically driven agitator was used to keep the lime in suspension.

The rate of flow of the waste liquor through the experimental plant was controlled by a constant-head-orifice box, the orifice of which was adjustable.

Sampling

Composite samples for laboratory analysis were obtained by collecting portions at intervals of one half hour. The plant was allowed to operate for one hour prior to the start of sampling. The following samples were collected: Raw, settled, and filtered.

Chemical Analyses

Chemical analyses were carried out as specified in "Standard Methods of Water Analysis,"[1] of the American Public Health Association.

pH—The pH value is an index of the hydrogen ion concentration and is important, since with abnormally high or low pH values, corresponding to highly alkaline or acid conditions of the waste, the normal biological life of streams and sewage treatment plants receiving the liquor cannot function. It is, therefore, a measure of the toxicity of the wastes discharged.

Alkalinity—The phenolphthalein and methyl orange alkalinity is recorded as parts per million of calcium carbonate. Acidity is recorded as minus alkalinity in parts per million.

Suspended Solids—Suspended solids, on samples of from 100 to 200 c.c., were determined with a Gooch crucible, and are reported in parts per million.

Color *—Refers to the intensity of the color of the waste liquors as compared with Platinum Cobalt standards. The color recorded is the "apparent color," as defined by "Standard Methods of Water Analysis."[1]

Biochemical Oxygen Demand—The biochemical oxygen demand of a waste liquor is the oxygen, expressed in parts per million, which is required for stabilization of the organic matter by aerobic bacterial action. When determining the biochemical oxygen demand of industrial wastes it is generally necessary to make certain adjustments of the pH of the waste in order to prevent inhibition of the bacterial action by toxic chemicals. The following method[2, 3, 4] was used and gave very consistent results. The dilution method was employed; dissolved oxygen determinations were made in the field directly upon collection, and from them the initial dissolved oxygen content of the incubated samples was computed. Dilution water was prepared by adding 300 p.p.m. of sodium bicarbonate to distilled water, and the pH then adjusted within the range 7.0 to 7.2 by use of hydrochloric

* In the previous experimental work the color recorded was the "true color." The method of reporting color has been revised for the following reasons: (1) Since we are concerned not only with the intensity of the color, but with the general appearance of the waste liquor during any phase of its treatment, and since "apparent color" is considered as including not only the "true color," or that in solution, but also any color produced by substances in suspension, it is believed that the latter is a more descriptive method of recording, and (2) if the color determinations were made on the basis of true color no measurement of color reduction by sand filtration would be obtained.

However, it will be observed that the apparent color of the effluent from the sand filter is the same as the true color of the effluent from the settling basin. If the true color of the settling basin effluent is desired, the reader has but to take the color of the sand filter effluent as tabulated.

acid (17.1 c.c./liter). The dilution water was then stored until the dissolved oxygen content was between 7.5 and 8.5 p.p.m. Upon using, the dilution water was seeded with 10 c.c. per liter of raw sewage not less than one day nor more than three days old. As each dilution was prepared the pH was determined *immediately* after addition of the waste liquor. The pH *must* fall in the range 6.5 to 8.0, or be adjusted *at once* to do so. The procedure from this point on is as specified in "Standard Methods of Water Analysis"[1] under "Biochemical Oxygen Demand—Dilution Method."

Criteria for Satisfactory Effluent

The factors to be considered in judging the suitability of an effluent for discharge into streams or sewage treatment plants are: Hydrogen-ion concentration, color, and biochemical oxygen demand. While no precise standards as to the purity of effluents can be adhered to, since local conditions largely govern, it is recognized that certain limits should be set as a standard.

In order not to inhibit the biological life of the receiving stream or sewage treatment plant it is recommended that the pH of both receiving bodies be within the range of 6.0–8.5 after combination with the waste treatment plant effluent. The amount of dilution supplied by the receiving unit makes the degree of treatment in regard to pH of effluents entirely subject to local conditions.

An effluent with a color of 100 or less should be maintained. Since a color of 100 is no more than a tinge, an effluent which meets this standard is considered very satisfactory.

As regards the biochemical oxygen demand, the dilution and dissolved oxygen supply of the receiving stream will govern entirely, and in the case of discharge into sewage treatment plants the oxygen demand load that is permissible for the sewage treatment plant will govern.

However, it generally follows in the chemical precipitation treatment of all textile waste liquors that when the color has been reduced to a satisfactory limit the biochemical oxygen demand also has been reduced satisfactorily.

Results

The results of the treatment of the color-shop wastes are best judged by the degree of perfection of coagulation and sedimentation, the effect of sand filtration as a final clarifying step, and the ease with which disposal of the resulting sludge can be accomplished.

Coagulation and Sedimentation

Precipitation with the following coagulants * was investigated: lime, ferric chloride, alum, calcium chloride, ferrous sulfate, and ferric sulfate individually; and the following in combination with lime: alum, ferric chloride, and ferrous sulfate. The effect of returning precipitated sludge

* Amounts of coagulants are based on the following formulas: Lime, $Ca(OH)_2$. Alum, $Al_2(SO_4)_3.18H_2O$. Calcium chloride, $CaCl_2.H_2O$. Ferric chloride, $FeCl_3.6H_2O$. Ferrous sulfate, $FeSO_4.7H_2O$. Ferric sulfate, $Fe_2(SO_4)_3.9H_2O$.

Cost of chemicals computed on a basis of carload lots F.O.B. as of October 1, 1934.

to the mixing tank as an aid to coagulation was also investigated. Ferric chloride, alum, calcium chloride, ferrous sulfate, and ferric sulfate were unsatisfactory when used individually.

Those chemicals which gave satisfactory results in the laboratory were studied with the experimental plant, and the results of typical runs are tabulated in Tables 1, 2, 3, and 4.

The agitator in the mixing tank was operated at 31 R.P.M., and the rate of treatment was 3.75 gallons per minute.

Comparing the effects of all the coagulants it was found that the most satisfactory and economical results were obtained by the use of lime, using returned sludge as an aid to coagulation. The experiments were accordingly concentrated on the use of lime as the principle coagulant.

Since, in the case of most textile waste liquors, the process of coagulation is primarily neutralization of the chemicals used in the dyeing process until the optimum pH for coagulation is reached, it would appear that the most logical and simplest method of arriving at the correct chemical dosage would be in terms of the alkalinity or acidity of the waste being treated. In the case of this particular waste liquor this was done in relation to the acidity of the waste. From an analysis of the results of the treatment with lime alone it appears that to reach the optimum pH of 6.5 the ratio of lime dose in p.p.m. to the acidity of the waste in p.p.m. is 1.0, roughly.

To determine the correct lime dose in p.p.m. then for treating any color-shop waste liquor by chemical precipitation it is necessary only to titrate a sample of the liquor to determine its acidity. The acidity in p.p.m. multiplied by the lime-acidity ratio is equal to the required dose of lime in p.p.m.; *i.e.* with an acidity of 600 and a ratio of 1.0 as recommended the lime dose would be 600 p.p.m.; and with a ratio of 0.5 the dose would become 300 p.p.m. of lime.

In a few cases good results were obtained with a lime-acidity ratio as low as 0.815, but in all cases a ratio of 1.0 assured good results. If less lime were used the floc settled slowly, if at all, and the effluent was high in color and very turbid; although the reduction in biochemical oxygen demand was generally as good as with the optimum dose.

The recommended dose resulted in a beautifully clear final effluent, in most cases as clear and colorless as drinking water, well below the color limit of 100. The pH obtained with a ratio of lime to acidity of 1.0 was about 6.5.

Better sedimentation, resulting in a slightly clearer effluent with a pH of about 9.0 was obtained by increasing the lime-acidity ratio to 1.25, but it is extremely doubtful that the increased clarity of the effluent justifies the additional cost.

Based on the average acidity of the color-shop wastes of 710 p.p.m. the average dose of lime to guarantee a satisfactory effluent would be 710 p.p.m. or 5.92 lbs. per thousand gallons. As a result of these experiments the amount of lime required for treatment of the color-shop wastes has been greatly reduced from the 23 lbs. per thousand gallons as formerly recommended,[5] and represents a substantial saving for treatment of these waste liquors.

A further reduction in the chemical dose is made possible by recirculation of sludge as an aid to coagulation. Preliminary tests made in the laboratory on liter samples gave best results when a volume of recirculated sludge equal to 18% of the volume of incoming raw liquor was used. Good

TABLE 1

TABLE 1

Chemicals	Chemical Dose		Cost of Chemicals per 1000 Gal.	Return Sludge %	Sample	pH	Results in p.p.m.				
							Alkalinity		Susp. Solids	Color	B.O.D. 5 day
	Lbs./1000 Gal.	p.p.m.					Total	Pheno.			
$Ca(OH)_2$	4	480	$0.0170	18	Raw	3.0–	−836	—		300	83.4
					Settled	5.4	22	0		400	31.0
					Filtered	5.9	49	0		300	31.0
$Ca(OH)_2$	4	480	0.0170	18	Raw	3.0–	−836	—	0	300	81.4
					Settled	5.4	20	0	41.4	400	26.2
					Filtered	5.9	40	0	20.2	300	26.2
$Ca(OH)_2$	4½	540	0.0191	18	Raw	3.0–	−836	—		300	67.0
					Settled	6.0	42	0		400	21.0
					Filtered	6.9	53	0		20	21.0
$Ca(OH)_2$	4½	540	0.0191	18	Raw	3.0–	−836	—	35.6	300	67.0
					Settled	6.2	37	0	65.9	300	21.0
					Filtered	6.9	63	0	0	20	21.0
$Ca(OH)_2$	4 13/16	576	0.0204	0	Raw	3.0–	−580	—	8.0	400	72.5
					Settled	6.3	50	0	31.0	500	37.5
					Filtered	6.9	42	0	22.0	20	35.1
$Ca(OH)_2$	5	600	0.0212	18	Raw	3.0–	−798	—	24.0	300	
					Settled	5.8	36	0	34.9	300	
					Filtered	5.8	38	0	9.3	75	
$Ca(OH)_2$	5⅞	705	0.0250	0	Raw	3.0	−520	—			47.5
					Settled	9.0	120	70			18.9
					Filtered	8.6	22	4			14.5
$Ca(OH)_2$	5⅞	705	0.0250	0	Raw	3.0–	−520	—	10.0	150	45.4
					Settled	9.0	90	50	19.0	200	15.0
					Filtered	9.0	57	35	0	20	15.3
$Ca(OH)_2$	5⅞	705	0.0250	0	Raw	3.0–	−720	—		300	77.5
					Settled	6.3	45	0		600	40.5
					Filtered	6.8	80	0		250	40.5
$Ca(OH)_2$	5⅞	705	0.0250	0	Raw	3.0–	−720	—	14.0	300	69.5
					Settled	6.3	50	0	56.0	700	39.5
					Filtered	6.2	60	0	50.0	700	39.6
$Ca(OH)_2$	6¼	750	0.0266	0	Raw	3.0–	−920	—	6.0	300	68.5
					Settled	6.7	55	0	27.0	250	43.2
					Filtered	7.3	36	0	3.3	20	38.8

TABLE 2

Chemicals	Chemical Dose		Cost of Chemicals per 1000 Gal.	Return Sludge %	Sample	pH	Results in p.p.m.				
							Alkalinity		Susp. Solids	Color	B.O.D. 5 day
	Lbs./1000 Gal.	p.p.m.					Total	Pheno.			
$Ca(OH)_2$	6¾	810	$0.0287	0	Raw	3.0−	−930	—	18.0	300	72.5
					Settled	9.6	130	40	20.0	200	40.2
					Filtered	6.9	28	0	1.3	40	40.8
$Ca(OH)_2$	6¾	810	0.0287	18	Raw	3.5	—	—	15.0	250	36.0
					Settled	9.6	344	299	27.5	60	18.0
					Filtered	9.6	273	222	0	20	18.0
$Ca(OH)_2$	6¾	810	0.0287	0	Raw	3.0−	−650	—		200	42.6
					Settled	9.0	240	170		200	26.8
					Filtered	9.0	149	109		20	25.8
$Ca(OH)_2$	6¾	810	0.0287	0	Raw	3.0−	−650	—	42.0	200	42.6
					Settled	9.0	230	170	36.0	200	26.1
					Filtered	9.0	182	144	6.0	25	25.6
$Ca(OH)_2$	6¾	810	0.0287	0	Raw	3.0−	−770	—	0	600	69.6
					Settled	6.4	45	0	18.0	300	33.8
					Filtered	6.9	34	0	8.0	20	32.2
$Ca(OH)_2$	6⅞	825	0.0292	0	Raw	3.0−	−940	—	0	300	71.5
					Settled	9.6	140	60	5.0	200	38.7
					Filtered	7.3	29	0	2.7	40	37.2
$Ca(OH)_2$	11⅞	1425	0.0505	0	Raw	3.0−	−520	—		350	56.8
					Settled	9.0	554	502		80	27.4
					Filtered	8.4	48	17		40	27.3
$Ca(OH)_2$	11⅞	1425	0.0505	0	Raw	3.0−	−530	—	10.0	350	56.4
					Settled	9.0	632	594	52.0	80	24.0
					Filtered	9.0	278	217	6.0	40	23.6
$Ca(OH)_2$	11⅞	1425	0.0505	18	Raw	3.0−	−540	—		350	61.4
					Settled	9.0	765	695		80	36.6
					Filtered	9.0	675	590		50	29.7
$Ca(OH)_2$	11⅞	1425	0.0505	18	Raw	3.0−	−540	—	14.0	350	60.5
					Settled	9.0	825	755	22.0	60	27.1
					Filtered	9.0	750	680	13.0	60	27.3

TABLE 3

Chemicals	Chemical Dose		Cost of Chemicals per 1000 Gal.	Return Sludge %	Sample	pH	Results in p.p.m.				
							Alkalinity		Susp. Solids	Color	B.O.D. 5 day
	Lbs./1000 Gal.	p.p.m.					Total	Pheno.			
$Ca(OH)_2$	4 1/8	495	$0.0175	0	Raw	3.0−	−470	—		250	57.5
$Al_2(SO_4)_3$	1/2	60	0.0068		Settled	7.2	40	0		400	26.4
					Filtered	8.4	38	19		30	34.4
$Ca(OH)_2$	4 1/8	495	0.0175	0	Raw	3.0−	−470	—	20.0	250	52.5
$Al_2(SO_4)_3$	1/2	60	0.0068		Settled	7.4	60	0	33.0	300	26.8
					Filtered	8.4	54	17	0	20	26.8
$Ca(OH)_2$	4 1/8	495	0.0175	18	Raw	3.0−	−470	—		250	48.0
$Al_2(SO_4)_3$	1/2	60	0.0068		Settled	7.4	40	0		200	20.2
					Filtered	8.4	27	2		10	21.1
$Ca(OH)_2$	4 1/8	495	0.0175	18	Raw	3.0−	−470	—	28.0	250	52.2
$Al_2(SO_4)_3$	1/2	60	0.0068		Settled	7.9	40	0	24.0	175	22.6
					Filtered	8.4	29	2	0	15	22.6
$Ca(OH)_2$	5	600	0.0212	0	Raw	3.0−	−450	—		250	56.0
$Al_2(SO_4)_3$	1/2	60	0.0068		Settled	8.6	40	10		150	23.0
					Filtered	8.6	25	2		20	23.6
$Ca(OH)_2$	5	600	0.0212	0	Raw	3.0	−450	—	22.0	250	53.0
$Al_2(SO_4)_3$	1/2	60	0.0068		Settled	8.6	75	30	36.0	175	22.0
					Filtered	8.4	21	2	2.0	20	20.5
$Ca(OH)_2$	5	600	0.0212	18	Raw	3.0−	−450	—		200	45.5
$Al_2(SO_4)_3$	1/2	60	0.0068		Settled	8.6	75	30		150	25.1
					Filtered	8.4	26	3		15	20.3
$Ca(OH)_2$	5	600	0.0212	18	Raw	3.0−	−450	—	28.0	200	47.5
$Al_2(SO_4)_3$	1/2	60	0.0068		Settled	8.8	95	35	26.0	175	24.7
					Filtered	8.6	40	15	0	20	26.1
$Ca(OH)_2$	5 7/8	705	0.0250	0	Raw	3.0−	−520	—		150	47.8
$FeCl_3$	1/2	60	0.0250		Settled	8.2	70	0		175	29.7
					Filtered	8.4	27	3		20	28.4
$Ca(OH)_2$	5 7/8	705	0.0250	0	Raw	3.0−	−520	—	8.0	150	45.8
$FeCl_3$	1/2	60	0.0250		Settled	8.4	70	5	35.0	150	26.7
					Filtered	8.4	27	3	2.0	20	28.3

TABLE 4

Chemicals	Chemical Dose		Cost of Chemicals per 1000 Gal.	Return Sludge %	Sample	pH	Results in p.p.m.				
							Alkalinity		Susp. Solids	Color	B.O.D. 5 day
	Lbs./1000 Gal.	p.p.m.					Total	Pheno.			
$Ca(OH)_2$	5⅞	705	$0.0250	18	Raw	3.0−	−520	—		150	44.0
$FeCl_3$	½	60	0.0250		Settled	8.5	85	20		150	24.3
					Filtered	8.2	21	0		15	25.7
$Ca(OH)_2$	5⅞	705	0.0250	18	Raw	3.0−	−520	—	8.0	150	40.0
$FeCl_3$	½	60	0.0250		Settled	8.6	85	30	27.0	150	23.3
					Filtered	8.4	23	23	3.0	10	24.7
$Ca(OH)_2$	6¾	810	0.0287	0	Raw	3.0−	−635	—		200	54.5
$FeSO_4$	½	60	0.0035		Settled	8.8	115	65		175	25.8
					Filtered	8.3	23	0		20	28.9
$Ca(OH)_2$	6¾	810	0.0287	0	Raw	3.0−	−635	—	30.0	200	47.1
$FeSO_4$	½	60	0.0035		Settled	8.8	135	75	41.0	150	24.0
					Filtered	8.6	41	15	14.0	20	27.6
$Ca(OH)_2$	6¾	810	0.0287	18	Raw	3.0−	−625	—		200	65.1
$FeSO_4$	½	60	0.0035		Settled	8.6	110	40		200	28.5
					Filtered	8.4	31	6		20	32.3
$Ca(OH)_2$	6¾	810	0.0287	18	Raw	3.0−	−625	—	48.0	200	59.5
$FeSO_4$	½	60	0.0035		Settled	8.6	120	55	25.0	200	29.0
					Filtered	8.6	55	24	8.0	25	31.2
$Ca(OH)_2$	6¾	810	0.0287	0	Raw	3.0−	−760	—		300	64.4
$Fe_2(SO_4)_3$	½	60	0.0063		Settled	6.9	45	0		400	38.8
					Filtered	8.4	54	6		30	37.5
$Ca(OH)_2$	6¾	810	0.0287	0	Raw	3.0−	−760	—	38.0	300	69.8
$Fe_2(SO_4)_3$	½	60	0.0063		Settled	6.9	45	0	45.0	400	34.2
					Filtered	8.4	50	7	8.0	30	33.4
$Ca(OH)_2$	7½	900	0.0318	0	Raw	3.0−	−740	—		300	69.0
$Fe_2(SO_4)_3$	½	60	0.0063		Settled	8.8	85	45		250	39.0
					Filtered	6.8	24	0		40	41.8
$Ca(OH)_2$	7½	900	0.0318	0	Raw	3.0−	−740	—	76.0	300	69.0
$Fe_2(SO_4)_3$	½	60	0.0063		Settled	8.8	130	80	44.0	250	36.6
					Filtered	6.8	27	0	24.0	60	39.7

clarification was obtained at a pH of 6.0 with a reduction in the lime-acidity ratio to 0.75, equivalent to an average lime dose of 533 p.p.m. or 4.44 lbs. per thousand gallons.

There appears to be no advantage in using lime in combination with either alum, ferric chloride, ferric sulfate, or ferrous sulfate. Making allowance for the lime required for neutralizing the acid salt in each case the lime-acidity ratio is still 1.0 to produce a pH of 6.5 or over. There is a slight improvement in some instances using two coagulants, but only in a slight decrease in the turbidity of the settling basin effluent and not enough to justify the added cost. The biochemical oxygen demand reduction is in general the same as with lime alone, being about 50% reduction throughout the experiments.

Sand Filtration

The effluent from the sedimentation basin was applied at the rate of 1.29 gallons per square foot per minute, 81.0 million gallons per acre per day, to a rapid sand filter having a bed of sand 20 inches in depth, the effective size of which was 0.45 mm. The use of some type of filtration was necessary to remove the finely divided floc which had been observed in all the previous laboratory studies, and which did not settle after several hours sedimentation, and which consequently imparted a high apparent color to the effluent. This floc in some cases, depending on the requirements, should be removed; in many cases it is quite possible that the filtration step can be modified or dispensed with entirely. The filter was back-washed at the rate of 24 inches rise per minute.

The loss of head at the end of the first hour of filtration averaged 0.66 foot.

Sludge Drying

The sludge drying beds followed the specifications for sewage sludge drying beds. Sludge was drawn on the beds to a depth of 4 to 4½ ins. At the end of four hours drying on a warm day the sludge dewatered to the extent that cracks had started forming. After four days drying the sludge cake contracted to about ¼ in. in thickness, and cracked up to such an extent as to seem to have disappeared from the bed. The per cent moisture of the sludge as drawn on the beds averaged 99.51%. Random samples of the sludge taken during the drying period showed a moisture content of 48.5% the third day after the sludge was drawn, 27.3% on the fourth day, 17.0% on the fifth day, and 1.39% moisture after six days drying. The entire period during drying was warm and clear. Of the solids approximately 34.0% were volatile, and 66.0% ash.

Discussion of Results

In practically every instance coagulation to some extent took place after settling, producing a finely divided floc and imparting a high turbidity to the settling basin effluent. At the time the settling basin effluent samples were collected they were very clear, having a color of 100 or less, but in the interval of about one hour between their collection in the field and the analyses in the laboratory, many of the samples developed a high turbidity. The color of the settling basin effluent was often as high or higher than that of the raw liquor. The color of the raw liquor, however, was due to

matter in solution and could not be removed by filtration, while that which developed in the settling basin effluent was imparted by suspended matter and was therefore removed by the sand filtration process.

The deferred coagulation is attributed mainly to the action of the mixing tank. A small portion of the flow obviously short-circuits through the mixing tank and consequently receives but a few minutes agitation,* while the major portion of the liquor is mixed for an hour or more. The small part which has received only a few minutes mix passed over to the settling basin and coagulation is completed there, or even after the liquor leaves the settling basin. It seems highly probable that even a relatively small amount of the waste liquor not receiving proper coagulation could impart the high turbidity to the settling basin effluent that has been observed.

The hypothesis that the high turbidity later developed in the samples of the settling basin effluent is due to short-circuiting taking place in the mixing tank is substantiated by quiescent sedimentation studies made in the mixing tank for that purpose. The assumption was made that if the mixing tank were operated on a batch process instead of continuous flow, thus eliminating the possibility of any short-circuiting between inlet and outlet, the deferred floc formation previously noted would not occur.

Therefore, runs were made on the batch process, allowing sedimentation to take place in the mixing tank by stopping the mixing apparatus after coagulation was complete. In order to compare this method with the continuous flow process the batch runs were made at the end of the day just after a continuous flow run had been completed. The tests, then, in both the continuous flow and batch runs were made on the same waste liquor with an identical dose of coagulant. Color determinations were made at intervals on the supernatant liquor in the mixing tank. Time of sedimentation was taken from the time the mixing apparatus was stopped.

Three such comparisons were made and in each case the assumption that no floc would develop after sedimentation had taken place was verified. For the first comparative run, at the end of fifteen minutes a color of 50 was recorded; after an hour a color of 30; and at the end of two hours a color of 80; indicating a tendency for the color to increase, but not enough to be harmful. The sample taken from the settling basin effluent when using the same chemical dose, but with the plant in continuous operation, had developed a color of 600 in one hour, and as such it was recorded. For the second comparative run, fifteen minutes sedimentation reduced the color to 20; one hour to 30; and after two hours settling a color of 50 was observed; and after six hours the color had not increased. Comparing these results with the color of 300, as recorded for the settling basin effluent on the same liquor with an equal dose of lime, it is apparent that the trouble lies in the performance of the mixing tank.† The third comparative run was substantially the same as the first two.

It will be necessary, then, to substitute a mixing basin that will produce the required mixing action with no possibility of short-circuiting taking place. A baffled chamber that will produce a slow mix, preceded by a

* Flow studies, subsequently made by the chloride method, showed that a part of the flow arrived in the settling basin after only a thirty second mixing period.

† The results of the field run, with which the results of the first comparative run are compared, are not included in the tables of this report; the run with which the results of the second comparative run are compared appears in Table 2 as the last run in which a dose of 6¾ lbs. of lime per thousand gallons was used.

hydraulic jump to obtain rapid mixing of the coagulants with the raw liquor, is thought to be the best solution. It will also be necessary to increase the period of sedimentation to three hours.

Conclusions

For chemical precipitation treatment of the color-shop waste liquors it has been determined that lime is the best and cheapest coagulant, and that a dose of 1 p.p.m. of lime for each 1 p.p.m. acidity of the raw liquor will produce a satisfactory effluent. The minimum pH for satisfactory coagulation is 6.5. Based on the average acidity of these waste liquors the average required dose is 710 p.p.m., or 5.92 lbs. of lime per thousand gallons. The cost of chemicals for treatment is $0.025 per thousand gallons. The use of recirculated sludge as an aid to coagulation reduces the chemical dose to 533 p.p.m. of lime, or 4.44 lbs. per thousand gallons, at a cost of $0.0189 per thousand gallons.

Treatment of the settling basin effluent by rapid sand filtration produces a beautifully clear and sparkling final effluent. Due to the inequalities of coagulation a considerably heavier load had to be carried by the sand filter than would have otherwise been the case. It also seems possible that the effective size of the filter sand can be increased above that used in these experiments. Under such conditions the length of filter runs would be materially increased.

The drying properties of the resultant sludge are entirely satisfactory, a sludge being produced that can easily be disposed of on sludge drying beds of sand.

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B. W. I. R. A. Non-shrinkable Wool Process

By C. H. CLARK*

Ever since the British Wool Industries Research Association made public in its annual report for 1933 (TEX. RSCH., April, 1934, pp. 304–6) reference to its discovery of a new process for rendering wool non-shrinkable, numerous articles have appeared in the trade and daily press that gave the impression that it had been perfected and was being utilized on a commercial scale.

Having received several inquiries from members as to the character and status of the process I addressed Mr. Arnold Frobisher, secretary, Wool Industries Research Association, Leeds, Eng., for information and the following is his reply:

> "In reply to your letter of the 17th inst. this Association has been carrying out a series of investigations on the shrinking of wool, and the public has from time to time been notified of these experiments in the press. A point, however, which does not seem to have been emphasized sufficiently is that the process is not yet fully developed for commercial use. In every application of science to industry, it has always been found that a considerable time must elapse between the working out of a method in the laboratory, and the time when it actually becomes a part of the manufacturer's routine.
>
> "We are of the opinion that references to the new unshrinkable process in the press (which have never been inspired by us) have given an incorrect impression to those interested in hosiery goods. It has been suggested that the new process is already an accomplished fact, and that goods treated by it should be available. This is not the case. We still have more work to do in solving the further problems which occur in transferring the operation of such a process from the laboratory to a commercial scale.
>
> "In accordance with these facts, it is certain that underwear or other knitted materials, finished by application of the W. I. R. A.'s new unshrinkable process, will not be available to the trade before 1936.
>
> "I might mention that the benefits which will eventually accrue from this process will be available only to members of this Association.
>
> "With reference to your enquiry about Prof. A. T. King, a misunderstanding has probably arisen in this connection owing to the fact that he was engaged at Torridon as our chief chemist previous to taking up his appointment at the University. He is, of course, one of joint patentees with regard to this process.
>
> "I trust that I have answered the points you raise and that it will enable you to give the necessary information to your enquirers."

W. I. R. A.'s new unshrinkable wool process involves the treatment of raw wool, tops, yarns or fabrics in a vacuum chamber with chlorine or bromine gas. The process is covered by B. P. 417,719 of the Wool Industries Research Association, A. T. King and R. A. E. Galley. The United States patent is still pending. The methods and claims of the patent are described in the *Textile Manufacturer*, Dec. 1934, p. 487–88, and this article is abstracted in *Textile World*, Feb. 1935, p. 81. A description of fancy color and weave effects that may result from this process can be found in articles by A. T. King in *Journal Society of Chemical Industry*, LIII, 1934, p. 339, and in the *Journal of the Textile Institute*, May, 1934, p. T184–88.

* Secretary, U. S. Institute for Textile Research, Inc.

Abstracts

This section is compiled under the direction of the Committee on Abstracts and Bibliography: Prof. E. R. Schwarz, Chairman, Dr. W. E. Emley, Prof. Louis A. Olney and M. W. Weiss.

I. Fibres (Synthetic and Natural) and Fibre Analysis

Dyes: Physical Condensation of—as a Means of Revealing the Fine Structure of Spun Fibres and the Nature of the Dyeing Process. Robert Haller and J. Okany-Schwarz. *Helv. Chim. Acta*, 1934, V. 17, P. 761–6 (German); cf. *Chem. Abs.*, V. 20, P. 825.

The histological character of single-cell spun fibres can be, to a considerable extent, made apparent by the method of phys. condensation of dyes thereon. The tech. bast fibres are, like cotton, thus shown to have a fine membrane or cuticle enclosing the cell wall. Flax fibres retted in warm H_2O and dyed with Naphthol AS developed by diazotized Fast Scarlet G show initially a homogeneous color distribution, but after soaking in cupridiethylenediamine hydroxide, a laminar structure of the lumen and cell wall is clearly defined. The displacements in ramie fibres are shown by this method with Ciba Brown 2R for one-half hour at 160°. Hemp fibres dyed with Ciba Violet B and heated in glycerol for one-half hour at 170° showed a marked structure similar to that of flax. Degummed hemp and materials treated with NaOCl until the cells are more or less opened up are similarly dyed, but are condensed in ale. for one-quarter hour at 160°. Jute fibres, so treated, show very strongly colored longitudinal stria throughout the lumen. This method may also be useful in differentiating between phys. and chem. combination of the dye and fibre. On wool, the condensation of vat dyes (Ciba Indigo 2R and Violet B) indicates a purely phys. process, whereas acid dyes appear to be chemically fixed and exhibit no condensation. Natural silk exactly resembles wool in this respect: with Violet B there are shown distinct longitudinal stripes which in cross-section appear as fine canal throughout the fibre. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 5987.) (W)

Fibres: Preservatives for. A. Bresser. *Z. ges. Textil-Ind.*, 1934, V. 37, P. 384–5.

Agents for mothproofing textile fibres and for protecting them against the action of chemicals are discussed. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 7031.) (W)

FLAX TOWS: STRUCTURE OF. V. Bossuyt and J. Gadenne. *Chim. & Ind.*, April, 1934, P. 858–62.

Photomicrographs are given and explained of flax retted to various degrees, and thus in different degrees of disintegration. When plotting the tensile strength of wet tow against the length of the sample (between the jaws of the tester), a sharp break in the curve occurs at the point corresponding to the length of the structural units of the tow. The breaks with fully disintegrated material occur at 7–8 cm., indicating that this is the elementary fibre length; with incompletely disintegrated material the breaks occur later as the units consist of incompletely sepd. fibres. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 5989.) (W)

FLAX FIBRE: PHYSIOLOGICAL CHARACTERISTICS OF. Oskar A. Walther. *Faserforschung*, 1934, V. 11, P. 63–78.

The influence of pH on the germination of flax seeds is different from its influence on the growth of the plant. Max. germination is at pH 5 and 9 with a min. at about 7, while max. growth varies between 6 and 8 according to the Mg content of the culture soln. At pH 5–6 the production of elementary fibres was optimal. Increase of K and P concn. of the culture soln. to twice the concn. of Knop's soln. increased the fibre yield up to 27%, but increase of N had the opposite effect: decrease in Mg also increases the yield. As N source NH_3, nitrate or urea can be used. At const. pH, increase in the Ca concn. of the culture soln. increases the no. of fibre bundles in the stem, and the extent of the increase is proportional to the P concn. of the soln. Shading of the plant, particularly during the latter part of its development, reduced the quality of the fibres considerably. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 5898.) (W)

HIGHLY POLYMERIZED COMPOUNDS. XCII. CONSTITUTION OF CELLULOSE. H. Staudinger. *Cellulosechem.*, 1934, V. 15, P. 53–9, 65–7; cf. *Chem. Abs.*, 1934, V. 28, Col. 3060, 6119, 6999. (W)

PFÜHL, VALUE. W. Steffens. *Textil-Forsch.*, 1934, V. 16, P. 46–9; *Chim. & Ind.*, V. 32, P. 415.

The Pfühl value which, since 1880, has fixed officially the moisture content of jute and jute products, does not correspond to the realities of com. practice. New control tests have shown that this value has only a purely scientific value, but is valueless for mfg. operations. The spinning of jute generally requires a much higher moisture content, which varies according to the quality of the raw material and the results desired. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 7023.) (W)

TWISTING OF COTTON FIBRES. Olivier Roehrich. *Chim. & Ind.*, April, 1934, P. 819–23.

When collodion tubes filled with water are dried in the oven, they produce spiral-shaped ribbons similar to cotton fibres. The reversals in the direction of the spirals of the cotton fibre, characterized by extinction in polarized light, furnish the explanation of the phenomenon. The direction of the twisting is invariably controlled by that of the fibrillar spiral of the secondary membrane of the cell wall. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 5990.) (W)

VISCOSE RAYON: DISTANCE BETWEEN THE MICELLES IN. N. Matsumoto. *J. Soc. Chem. Ind. Japan* 37, Suppl. binding, 1934, P. 356.

Fibres mfd. under the same spinning conditions, but varying in diameter from 7.26 to 36.20 μ were examd. by means of X-ray patterns. The mean distances were for this range about 65 A. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 7003.) (W)

II. YARNS AND FABRICS

ABSORPTION AND RELEASE OF MOISTURE OF FIBROUS MATERIAL ON AIR HUMIDITY AND TEMPERATURE: DEPENDENCE OF. W. Weltzien and W. Rhein. *Monatsh. Seide Kunsteide*, 1934, V. 39, P. 343–9, 390–4; *Chem. Abs.*, 1934, V. 28, Col. 7023.

A simple method is described for detg. dependable figures for the absorption and loss of moisture of various textiles within moderate changes of conditions. The app is shown by a drawing. (W)

ACID MILLING OF MORDANT-DYED WOOLENS. W. Jockers. *Tex. Mfr.*, 1934, V. 60, P. 287, 290.

Mordant-dyed (I) and coarse (II) woolen cloths shrank only 90 and 85%, resp., in area as compared to 100% in the same undyed fabric, in acid milling. Upon the addn. of 0.5 l. of sulfonated castor oil in 14 l. of pH 1.5 H_2SO_4 milling soln., the pH of the soln. changed to approx. 1.65, and the shrinkage was I 138 and II 119% in area, as compared to the 100% shrinkage of the same fabrics in the acid soln. only. The sulfonated castor oil also reduces or eliminates color changes in the dyed material during milling, gives a whiter color in the undyed fabrics, and a firmer, more bulky, and superior handle in the finished cloths. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 7028.) (W)

DELUSTERING OF RAYON. R. Hünlich. *Kunstseide*, 1934, V. 16, P. 266–8.

A review of some recent German patents. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 7026.) (W)

DYES: EFFECT OF—ON THE REFLECTION OF LIGHT FROM TEXTILES. R. Guelke and Margaret M. Fitzsimons. *Trans. Faraday Soc.*, 1934, V. 30, P. 512–19; *Chem. Abs.*, 1934, V. 28, Col. 6569. (W)

FADING: COMPARISON OF THE—PRODUCED BY THE FADE-OMETER (TYPE LV) AND BY SUNLIGHT. Marion E. Griffith, Wallace R. Brode and Henrietta Robertson. Ohio Agr. Sta. *Bimonthly Bull.*, 1934, V. 169, P. 143–6; *Chem. Abs.*, 1934, V. 28, Col. 7021. (W)

FABRIC STRUCTURE AND LAUNDERABILITY. R. E. V. Hampson. *J. T. I.*, 1934, V. 25, P. 207–14; cf. *Chem. Abs.*, 1934, V. 28, Col. 3238.

To show the need for greater co-operation between the fabric manufacturer and the launderer, the laundering process is briefly described, and the requirements of a launderable fabric with respect to fibre composition and fabric construction are discussed. Examples and causes of unlaunderable fabrics are cited. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 5675.) (W)

FLEXIBLE AND NONWRINKLING FINISHING MATERIALS. Paul Wengraf. *Rev. mat. color,* 1934, V. 38, P. 281–4.

A résumé of processes and patents of recent years is presented. (Copied complete from *Chem. Abs.,* 1934, V. 28, Col. 5675.) (W)

LATEX IN THE TEXTILE INDUSTRY. Rudolf Günther. *Monatsh. Seide Kunstseide,* 1934, V. 39, P. 291–2, 294.

The prepn. and uses of rubber latex concentrates are discussed. Latex when added to viscose soln. produces a stronger yarn, more elastic, duller and less sensitive to moisture. Emulsified oils with latex give rayon a handle similar to silk. Other uses include the back-sizing of velvets, prevention of slipping of threads in rayon taffetas, and use as adhesive in binding. Cu and Mn are to be avoided. Seven references. (Copied complete from *Chem. Abs.,* 1934, V. 28, Col. 7022.) (W)

OILS AND STAINS. H. R. Hirst. *J. Soc. Dyers & Col.,* 1934, V. 50, P. 211–15.

Oil stains are classified as: (1) oils which produce discoloration of the fibres, temporarily on undyed material, or persisting after dyeing and finishing, and (2) oils which give invisible films and produce stains or unevenness in subsequent processes. Means of detg. the type of stain and the types of oil used in machine lubrication are discussed. (Copied complete from *Chem. Abs.,* 1934, V. 28, Col. 5991.) (W)

OXYCELLULOSE: FORMATION OF—DURING BUCKING IN AIR-CONTAINING BOILERS. Leo Kollmann. *Z. ges. Textil-Ind.,* 1933, V. 36, P. 497.

Results of tests on crude cotton yarn (English No. 20/2) having a tensile strength of 613 g. which were performed in a deaerated boiler, a nondeaerated boiler and a boiler contg. an excess of O, by submerging the yarn either partly or completely in 10 g. NaOH per 1. for 1 hr. at 2.5 atm. or else by merely moistening it with the lye, showed that no appreciable damage occurred except in the last case. Neither the removal of air nor the presence of excess O caused any appreciable damage. Addnl. tests in which the cotton yarn was first covered with a very thin layer of Fe hydroxide previous to its treatment in the nondeaerated bolier showed that in the presence of catalytic Fe the O of the air causes considerable damage to the textile. In this last case the tensile strength is decreased as much as 62.3%. (Copied complete from *Chem. Abs.,* 1934, V. 28, Col. 7001.) (W)

RAYON CREPE AND ITS DEVELOPMENT. (German.) K. Spindler. *Die Kunstseide,* May, 1934, P. 165–170.

Rayon crepe has in general developed through experience as derived from handling silk. The difference existing between this material and the silk goods have caused trouble in the processing and are pointed out in this article. Further the crepeing process, from twisting to weaving and finally to the finishing operation, is described in some detail. The difficulties which may occur during the process are indicated together with brief comments as to how they may be avoided. Finally there is a brief discussion of methods of crepeing in which shrinking agents are employed. (S)

RINSING AND WASHING WOOLEN PIECES. W. Pflumm. *Z. gen. Textil-Ind.*, 1934, V. 37, P. 466–7; *Chem. Abs.*, 1934, V. 28, Col. 7030. (W)

ROSINS, VISCOSE, ETC., IN FINISHING COTTON CLOTHS. J. A. Clark. *Tex. Mfr.*, 1934, V. 60, P. 293–4; *Chem. Abs.*, 1934, V. 28, Col. 3910, 7024. (W)

RUBBERIZED TEXTILES: PRODUCTION OF. F. C. Pratt. *Tex. Col.*, 1934, V. 56, P. 173–5, 204.

The phys. and chem. properties of rubber latex are discussed and its application to textiles is described. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 5713.) (W)

III. CHEMICAL AND OTHER PROCESSING (NOT OTHERWISE CLASSIFIED)

ABSORPTION OF DIRECT DYESTUFFS BY CELLULOSE: EFFECT OF ELECTROLYTES ON THE. A. M. Patel. *Am. Dye. Rptr.*, 1934, V. 23, No. 19, P. 505–8, 521.

The article includes an explanation put forward for the interpretation of the mechanism of dyeing which is intended to explain the following facts in the case of the substantive process:—the absence of any dyeing property of the majority of the substantive dyestuffs in the absence of the sulfate or chloride of sodium; the effect of the addition of various electrolytes on the amount of dye absorbed; and the poor fastness to washing that is exhibited by almost all the substantive dyestuffs. (S)

BLEACHING ON THE WHITENESS AND TENSILE STRENGTH OF COTTON FABRICS: THE INFLUENCE OF. George H. Johnson, A. I. Anderson, H. O. Parker and J. D. MacMahon. *Am. Dye. Rptr.*, 1934, V. 23, No. 19, P. 519–20.

This is an abstract from Special Report No. 53 of the Laundryowners National Association. A summary covers the following items: Different cotton fabrics, when subjected to the same washing formula, show a wide variation in the degree to which they retain their original whiteness and pre-laundered tensile strength. To obtain satisfactory whiteness retention in white cotton fabrics the use of bleach is required in the washing formula. To obtain satisfactory whiteness retention, no more than two quarts of a 1.0% available chlorine solution is required for each 100 pounds dry weight of load in the washer. Any use of bleach in excess of this amount rapidly increases tensile strength losses, but results in practically no improvement in whiteness. To obtain satisfactory whiteness rentention, efficient detergent operations are also required. Conclusions clearly show (1) that it is impractical to attempt to wash work white and (2) that it is unsafe to try to bleach work clean. (S)

DIRECT DYEING: A RECENT REVIEW OF. Chas. F. Goldthwait. *Am. Dye.*

A study of the literature of the direct dyeing of cellulose discloses at once that there are under development several somewhat dissimilar lines of thought. Most of the main points may eventually harmonize in the final true explanation of the mechanism of direct dyeing. This article is mainly a review of several recent publications pertinent to one of these divisions of

thought, the original papers being partly in journals which are not widely available. (S)

DYE AND FIBRE: NATURE OF THE COMBINATION BETWEEN. Jerome Alexander. *Am. Dye. Rptr.*, 1934, V. 23, No. 25, P. 668–72, 678–80.

This is a popular paper presented at a meeting of the New York Section of the American Association of Textile Chemists and Colorists on October 26th, 1934. This is an excellent example of popular interpretation of scientific research. (S)

DYEWORKS EFFLUENT PURIFICATION. SOME NOTES ON A PURIFICATION PLANT WHICH GAVE SATISFACTION. A. J. Hall. *Am. Dye. Rptr.*, 1934, V. 23, No. 25, P. 661–4, 666.

Some few years ago the writer was concerned with a plant carrying on bleaching and dyeing and which had to empty its effluent into a somewhat small stream without polluting it sufficiently to injure fish life or cause annoyance to neighboring industrial users. This problem of effluent purification is one which confronts other dyeing works and for this reason it is thought that some details of the methods of purification which were successfully employed in this one instance may be helpful to other works. It is not claimed that the purification system used is the only one which would prove satisfactory but merely that it was actually found to yield an effluent having satisfactory characteristics. (S)

FLOWING OF HIGH VISCOSITY LIQUIDS THROUGH RECTANGULAR CANALS OF SMALL CROSS-SECTION IN RAYON. (German.) R. Focke. *Die Kunstseide*, 1934, V. 16, No. 9, P. 297–303.

This is the conclusion of an article which appeared in the previous number of this journal (August, 1934) and deals with experimental work in connection with the flow of viscous fluids in very small channels. This is of importance in connection with the action of rayon filaments of irregular cross-section in solutions of this character, such as would be found in various dyeing, sizing and other treatments. The work is theoretical. The construction of charts which can be of use in practical work is given, and it is indicated that these diagrams can be of practical importance to plant workers. (S)

SPRAY PRINTING OF DYES. H. W. Ellinger. *Kunstseide*, 1934, V. 16, P. 270–1; *Chem. Abs.*, 1934, V. 28, Col. 7019. (W)

STABILITY OF HYDROGEN PEROXIDE BATHS DURING THE BLEACHING OF VARIOUS FIBRES. Karl Lorenz. *Monatschr. Textil-Ind.*, 1934, V. 49, P. 112; *Chem. Abs.*, 1934, V. 28, Col. 7029. (W)

STREPTO AND HETEROCYCLO POLYMETHINE DYES FROM FURFURAL AND ITS VINYLENE HOMOLOGS. W. König, K. Hey, F. Schulze, E. Silberkweit and K. Trautman. *Ber.*, 1934, V. 67B, P. 1274–96; *Chem. Abs.*, 1934, V. 28, Col. 5820. (W)

SULFUR CHAMBER: RATIONAL MODERN. M. Loescher. *Z. ges. Textil-Ind.*, 1934, V. 37, P. 398–9.

A description of the construction and use of a modern sulfur chamber for bleaching wool and woolen goods. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 7030.) (W)

SYNTHETIC DYESTUFFS: RECENT PROBLEMS ON THE CONSTITUTION OF SOME IMPORTANT. T. Maki. *J. Chem. Soc. Japan* 55, Suppl. to No. 7, 1934, P. 57–71; *Chem. Abs.*, 1934, V. 28, Col. 6315. (W)

TECHNICAL DYEING OF SURFACE-ACTIVE SUBSTANCES ON THE NAPHTHOLS OF THE AS SERIES: ACTION IN. II. H. Gerstner. *Monatsh. Seide Kunstseide*, 1933, V. 38, P. 463–70; *Chem. Zentr.*, 1933, V. II, P. 3918; *Chem. Abs.*, 1934, V. 28, Col. 2539, 7019. (W)

TRANSPARENT EFFECTS ON SILK. R. Hünlich. *Monatsh. Seide Kunstseide*, 1934, V. 39, P. 194–6.

Inorg. swelling agents act on silk to increase transparency, change the sheen, equalize thread size, stiffen the silk and alter the dyeing properties. The swelling agent used, its concn. and the temp. are important factors to the desired result but time is especially important. Mild swelling agents tend mostly to equalize thread size; stronger ones to increase transparency. Care must be taken that the agents used do not cause a wrinkling of the threads or the desired transparency is not obtained. Swelling agents which may be used are NaOH, KOH, mineral acids except HNO_3 and solns. of simple or complex salts such as $ZnCl_2$, ammoniacal Cu and Ni oxides, alk. Cu-glycerol soln. and thiocyanates. Selection of the proper swelling agent permits a wide variation in operating conditions such as concn., temp., time, etc. Mixts. of these agents, if compatible, may be used or treatment with one may follow that with another. Specific examples of conditions to be employed are given in Ger. pats. 593,721–2 (*Chem. Abs.*, V. 28, Col. 3598). Depending on the agent employed, temps. may run from 5° to 50°, times from 5 to 60 sec., concn. of the agent depends on the agent used, *e.g.*, $ZnCl_2$ solns. of 65° Bé., H_2SO_4 of 54° Bé. and NaOH of d. 1.21 are mentioned. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 7543.) (W)

VAT DYES: USE OF—FOR DISCHARGE DYEING ON ACETATE RAYON. C. Babey. *Russa*, 1934, V. 9, P. 661; *Chem. Abs.*, 1934, V. 28, Col. 5244, 7538. (W)

VAT DYES OF THE BENZANTHRONE SERIES. VI. REACTION PRODUCTS OF ISOVIOLANTHRONE CONDENSATION. T. Maki and Y. Nagai. *J. Soc. Chem. Ind., Japan* 37, Suppl. Binding, 1934, P. 213–6; cf. *Chem. Abs.*, 1933, V. 27, P. 3931; 1934, V. 28, Col. 329, 5435. (W)

WOOL: FAST GREEN DYEING ON—WITH SCHAEFFER SALT. N. A. Suikhra and S. G. Abramovich. *Anilin. Prom.*, 1934, V. 4, P. 167–8; *Chem. Abs.*, 1934, V. 28, Col. 5673. (W)

WOOL: LOGWOOD BLACK ON. G. Raeman. *Dyer*, 1934, V. 72, P. 18–9.

A modified, one-bath process, in which are used small amounts of $K_2Cr_2O_7$ and $CuSO_4$, is described. The result claimed is the desirable characteristic color of logwood black, with improved color fastness to light. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 5673.) (W)

IV. Research Methods and Apparatus

Mildew Resistance of Outdoor Cotton Fabrics: Laboratory Tests for. Charles Thom, Harry Humfield and H. P. Holman. *Am. Dye. Rptr.*, 1934, V. 23, No. 22, P. 581–6.

Some of the tests reported in the literature are reviewed. A practical laboratory test for effectiveness of mildew proofing agents applied to cotton fabric is outlined. Results obtained with this test on a number of commercial treatments are given. (S)

New Ultraviolet Microscope Illuminator. Thomas Hill Daugherty and Elmer V. Hjort. *Rayon and Mell. Tex. Mo.*, 1934, V, 15, No. 12, P. 45–6.

The article discusses preliminary studies of the use of a new type of ultra-violet source for microscopy of rayon. The device is essentially an Annular Mercury Arc which may be used above the stage of the microscope surrounding the objective and lighting the specimen on the same principle as the familiar Silverman illuminator does with ordinary light. It is intended primarily for use in fluorescence tests of textile materials and a table is included which shows the fluorescent characteristics of the rayons. (S)

Polarization Strength of Fluorescent Light. J. Cahen. *J. Chim. Phys.*, June 25, 1933, P. 420–8.

The experimental procedure is described and the results are tabulated for polarization values of fluorescent light for a number of dyes in respect to the viscosity of the solvents, glycerin, glycerin and water, and water. Among the compounds studied are eosine, erythrosine, fluorescein, phenosafranine, rhodamine B, etc. The polarization value decreases with a decided decrease in temperature. Decreased wave length of exciting light causes strong negative polarization in the fluorescence of rhodamine B at 3700 A. and rhodamine S at 3100 A. (Copied complete from *Eastman Kodak Abs. Bull.*, Oct., 1934, P. 367.) (S)

Rayon: Determination of Contents of—in Mixed Textile Fabric. Henrich Pincass. *Z. ges. Textil-Ind.*, 1933, V. 36, P. 318; *Chem. Abs.*, 1934, V. 28, Col. 7542. (W)

Rayon Identification. A. S. T. M. Rayon Sub-Committee. *Am. Dye. Rptr.*, 1934, V. 23, No. 17, P. 241–6.

The systematic scheme outlined in this article when carried out in the given sequence will serve for rapid identification of rayon. It is stressed that the method can be depended upon by an experienced analyst, particularly when used in conjunction with filament count and microscopical characteristics. For an inexperienced man, the detailed method of rayon analysis is recommended and is included in the article. It is also noted that comparison of the unknown rayon with standard samples of known make should be made wherever possible and that the standard should be as inclusive of the rayon field as possible and should be kept up to date. (S)